Defense Technical Information Center Compilation Part Notice

ADP010966

TITLE: Minimizing the Software Re-design in Obsolescent Radar Processors with Functional Radar Simulation and Software Workshop

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components [Strategies visant a attenuer l'obsolescence des systemes par l'emploi de composants du commerce]

To order the complete compilation report, use: ADA394911

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:
ADP010960 thru ADP010986

Minimizing the Software Re-design in Obsolescent Radar Processors with Functional Radar Simulation and Software Workshop

Philippe LACOMME – Véronique BARET
THOMSON-CSF DETEXIS France
La clef de Saint-Pierre
1 boulevard Jean Moulin
78852 Elancourt Cedex
France

Abstract

Signal and Data Processors are the sub-assemblies which are the most likely obsolescent parts in modern airborne Radars. As their architecture is based on multiple parallel COTS processors, the implementation of the algorithms in these processors is a costly and time consuming task which represents the most significant part of the cost when the sub-assembly has to be replaced due to component obsolescence.
The use of a powerful software workshop is the way to dramatically cut the cost of the software redesign by an extended re-use policy.

A significant improvement in the radar development cycle can be achieved through simulation techniques. These new tools and methodology enables to reduce costs and to shorten the radar modes development cycle.
During the phase of specification, a functional radar prototype is developed, requirements are defined, and testing procedures are developed. This functional radar prototype is completely independent of the processor hardware and survives to COTS obsolescence.
During the phase of on-board functional software development, the functional prototype is re-used to simulate the machine architecture (processors in parallel, communications, …) and the algorithms are optimized for the target processor hardware.
During the testing phase, a cross test between the functional prototype and the on-board functional software can be performed by the re-use of the testing procedures. Also, the flight tests can be prepared by the simulation of the scenario to be played.
The designer can be assisted by a tools for all this developments.

1. Introduction

New radars or new radar modes become more and more complex. The sophisticated signal processing algorithms and the real time requirements need multiple processors machines. To reduce the cost of radar development, to shorten development cycles, and to cope with obsolescence problems of the processor hardware, a new methodology based on simulation and re-use of simulation software is applied in THOMSON-CSF DETEXIS for some years.

The main means of this new methodology are:

- further use of simulation techniques in the phases of system specification and design,
- re-use of simulation software modules in embedded software,
- set up of two workshops (simulation and processing machines).

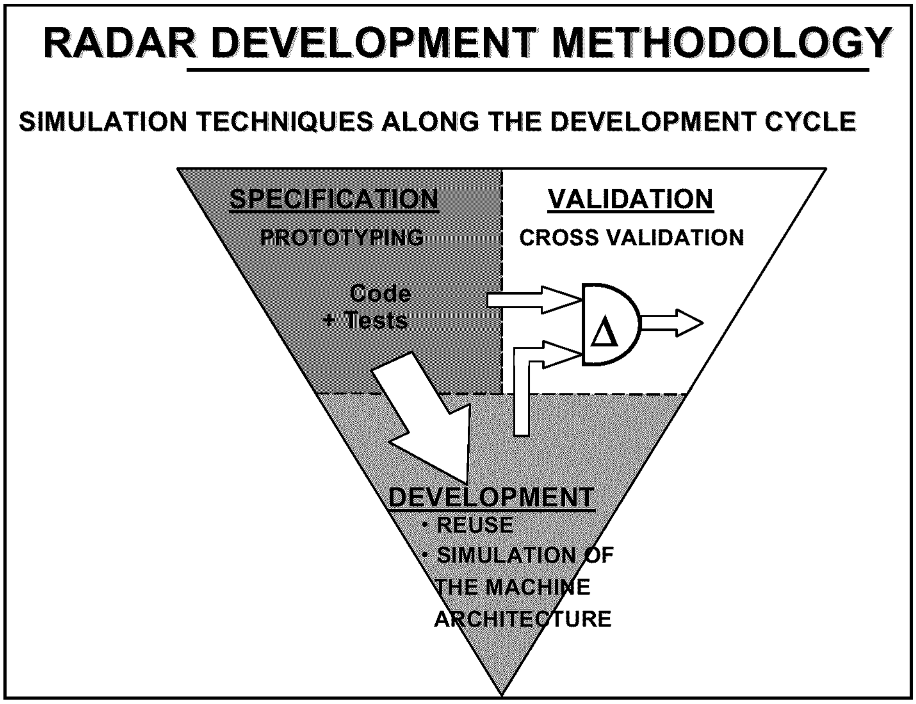
In a classical approach, 4 distinct software were developed:

- advanced studies software to design algorithms,
- function modelling software for radar design,
- applicative software,
- data analysis software to process in-flight recorded data.

Paper presented at the RTO SCI Symposium on "Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components", held in Budapest, Hungary, 23-25 October 2000, and published in RTO MP-072.

The new approach consists in re-using a same software for different tasks. In fact, 3 out of these 4 software run on a host machine (work station); the software used for prototyping the radar can be exactly the same as the software for analyzing the in-flight recorded data. The software for advanced studies can be re-used for the radar design. So, on the host machine (workstation), we can have a single software (or a re-use of code). This software being completely independent of the hardware, it is not affected by obsolescence. For on-board software, the problem is quite different : this software runs on a target processor which implies a lot of constraints. The solution is to re-use the software running on the workstation for assisting the designer to develop the on-board software : source code can be re-used.

To illustrate the simulation, we can consider a 3 phases development cycle: specification, on-board software development, and validation.



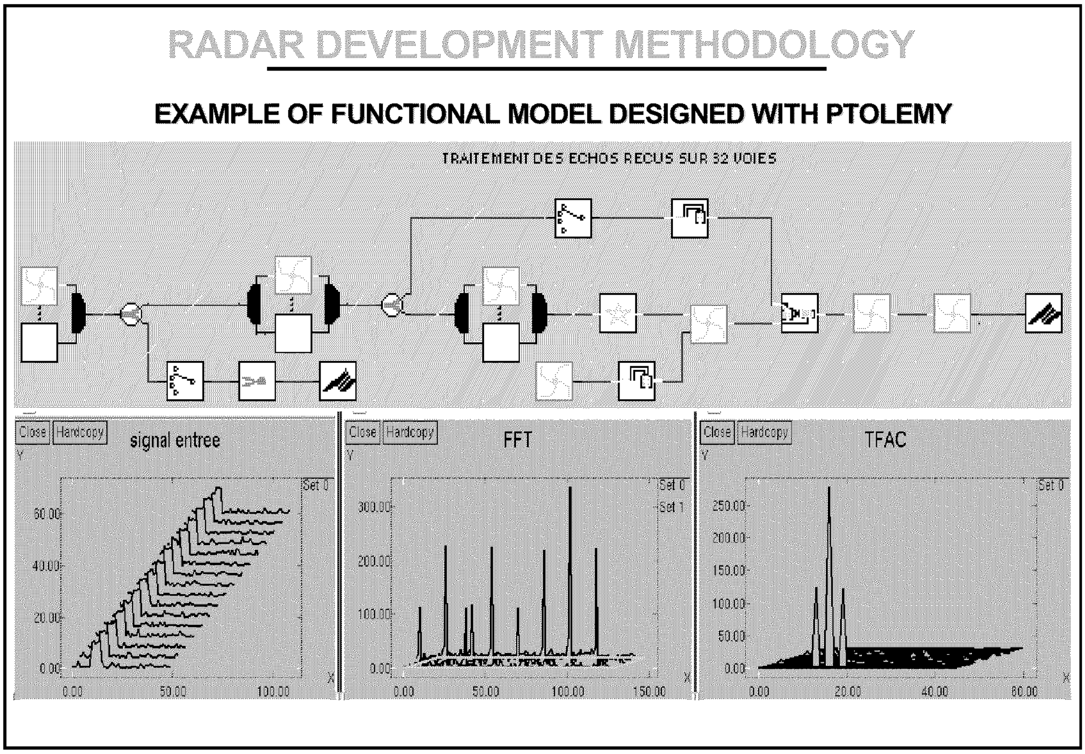
Simulation techniques used during the main phases of a development cycle.

2. Virtual prototyping

During the specification phase, simulation can be used for prototyping the virtual radar on an host machine (workstation). This radar prototype allows to:

- design the functionality of the radar mode and to define the interfaces between the different modules of the radar,
- specify the exact algorithm which is needed (to avoid overspecification),
- evaluate the radar performance, such as resolution for an air to ground mode or detection range for an air to air mode,
- and finally define the validation procedures. The prototype software is verified with these testing procedures, which are the functional reference for the radar mode. These procedures will be re-used at the validation phase.

This virtual prototype is independent of the hardware technology and is represents the “reference” of the radar.
Then the designer can be assisted by a tool for the development of the radar prototype software: a tool (such as Ptolemy) can facilitate the designer’s work. A toolbox is created with a library containing signal and data processing algorithms. The designer can build the prototype and takes each algorithm he needs from the toolbox and then links together the algorithms with a specific tool. Then on workstation, final output or intermediate output can be verified.



Example of functional model with the tool Ptolemy

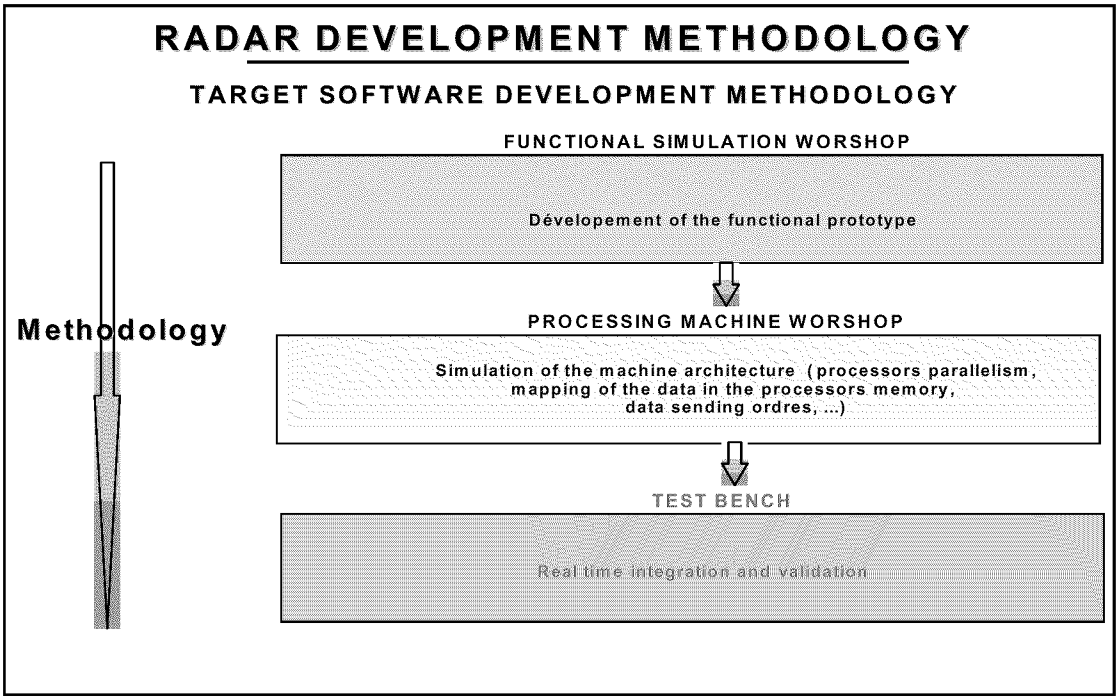
3. On-board software development (new hardware design)

The second main phase of a radar mode development is the on-board software development. With the virtual prototype, a signal and data processing software is available; this software runs on workstation (single processor environment). At the end of this phase, the on-board software must run on a multi-processors machine. To re-use the virtual prototype software, the methodology is as followed:

- in a first phase, a model, matched to the processor architecture, is developed on the basis of the functional model, taking into account the architecture and the characteristics of the machine.
- in a second phase, each algorithm is compiled and optimized for the target processor. For each algorithm, the number of cycles and the memory size must be known. This is possible if the processor accepts algorithm in a language such as C or C++, ...which is the case of new COTS DSP or processor.
- In a third phase, the software is linked and loaded in the target machine and can be verified on the test bench.

This methodology is of interest also because it enables the designer to disconnect the problems : the algorithm problems are seen during the functional model development; the parallelism, memory mapping or communication problems are seen during the development phase of the model matched to the target architecture. When working on the hardware test bench, all these problems are solved and the designer can concentrate on real-time problems.

The designer can be assisted by tools to optimize the algorithms implementation on processors. For example, a tool can measure the workload ratio for each processor or evaluate time for data processing . Some tools also generate the source code for each processor and software for communication between processors or between the different memories of a processor.



The different phases of the on-board software development

4. Validation

The third main phase of a development cycle is the validation. During this phase the testing procedures, defined at the specification phase (and run on the functional prototype on workstation), are played on the radar on the test bench, and the both results can be compared. By that way, the functional requirements can be verified.

Always in the phase of validation, simulation techniques can be used for assisting flight tests.

- The scenario that will be played in flight can be played first on the virtual prototype on the host machine. So, flight tests can be prepared, and results can be analysed.
- Simulation techniques allow evaluation and validation in a complex environment. For example it is possible to add on recorded data, some synthetic data: targets, jammers…

5. Conclusion

In conclusion, using simulation techniques all along the development cycle enables to design the functional prototype of the radar which is the reference of the radar architecture, modes and algorithms. As this reference is not technology dependant, it can be re-used when the hardware has to be upgraded minimising the redesign and validation cost. On the other hand, libraries of algorithms, subassembly models and workshops can be re-used for new radar product developments to design the new functional prototype. It also helps the designer to develop the on-board software, to do cross-testing between the functional prototype and the on-board software, and finally to prepare the flight trials.
A cost saving (and time saving) by a factor 2 to 3 has already be demonstrated either for new developments or for processor upgrades.